

SHIFTGRAMS

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Take a word (for example, MUSIC), shift each letter n steps along the alphabet arranged in a circle with A following Z (for example, M eight steps to U, U eight steps to C, S eight steps to A, I eight steps to Q, C eight steps to K), and rearrange the resulting letters to form another word (for example, UCAQK to QUACK). Howard Bergerson, writing under a pseudonym, christened QUACK a shiftgram of MUSIC in "Sea-Changed Words" in the February 1969 Word Ways. (MUSIC is, of course, a shiftgram of QUACK, achieved by shifting $26 - 8 = 18$ spaces.) Multiple shiftgrams are possible (the earlier article exhibited the triple WHORLS, TAXIED, POLITE); however, the theoretical maximum of 26 shiftgrams of a word is impossible to achieve for words of four or fewer letters because of the paucity of vowels (AEIOUY used four times apiece takes care of at most 24 words), and equally impossible for words of five or more letters because of the sparseness of words. Transpositions are special cases of shiftgrams when the number n of steps equals zero, and alphabetic letter shifts (for example, CHEER to JOLLY) are special cases of shiftgrams when the final arrangement of letters is unnecessary (for details on these, see the editor's article in the November 1979 Word Ways).

It is rather surprising that no articles on shiftgrams have appeared in Word Ways since their introduction by Bergerson. This note presents the results of my investigation of the problem, based on boldface entries in Webster's New International Dictionary, Second or Third Edition. First, I exhibit shiftgrams for nine-letter words starting with each letter of the alphabet in turn (can the examples for Q and X be improved?):

areophane + 4 = silverite
 becoiffed + 3 = highflier
 cablegram + 2 = decocting
 deplaster + 15 = spaghetti
 enrapture + 13 = rechanger
 Fabrikoid + 3 = ungrilled
 gasometry + 20 = amusingly
 harvestry + 13 = refueling
 inhumanly + 6 = tetragons
 jackshaft + 8 = skipbrain
 Kellaways + 8 = mitigates
 lingberry + 13 = elevatory
 metatatic + 11 = expellent

nervature + 13 = rehearing
 outweapon + 14 = dobchicks
 plexiform + 18 = thinkable
 quadrants + 26 = squadrant
 ransacked + 4 = overweigh
 straphead + 11 = scalloped
 tegulated + 7 = bankshall
 uncharily + 6 = exorating
 viperfish + 22 = bandoleer
 wanhopely + 4 = particles
 xeronates + 26 = exornates
 yaghourts + 20 = olibanums
 Zephaniah + 4 = delimiter

Shifting gears, is it possible to find examples of each step size, from

1 through 26, for eight-letter words? No trouble at all:

watermen + 1 = snuffbox
 flasking + 2 = chipmunk
 bookable + 3 = deerhorn
 partaker + 4 = exvotive
 zampogna + 5 = truffles
 Quisling + 6 = motorway
 begotten + 7 = alluvian
 folkways + 8 = sweating
 figurize + 9 = raindrop
 quibbled + 10 = novellas
 Dedanite + 11 = polytope
 wishbone + 12 = quantize
 bangster + 13 = frontage

megapode + 14 = crusados
 lanceted + 15 = practist
 subraces + 16 = quirkish
 runnable + 17 = versicle
 Mameluco + 18 = mugweeds
 habitual + 19 = abutment
 keckling + 20 = wheyface
 indrafts + 21 = vadimony
 sageship + 22 = lacewood
 Heliodor + 23 = foilable
 conjunct + 24 = Marshall
 repuffed + 25 = decoated
 bestiary + 26 = sybarite

This list can immediately be reduced to only 14 examples because the first entry is both a 1-shift and a 25-shift, the second entry is both a 2-shift and a 24-shift, etc. (note that the 13-shift and the 26-shift are not paired).

Can one generate a list exhibiting both alphabetic and step variation in synchrony? Two constraints together are more difficult to satisfy than either one alone; I was able to achieve it for six-letter words, but with no entries for either X or Y:

amhran + 1 = bobins
 became + 2 = cogged
 Cabiri + 3 = fullred
 daekon + 4 = hosier
 endive + 5 = jinjas
 faucal + 6 = riggal
 gambit + 7 = hatpin
 hallah + 8 = pitpit
 infers + 9 = wabron
 jadery + 10 = kinbot
 Khatti + 11 = svelte
 loggia + 12 = saxsum
 morgana + 13 = tanzeb

naique + 14 = bowsie
 oarlap + 15 = gapped
 polyve + 16 = befoul
 quandy + 17 = hurple
 roting + 18 = fylgja
 Saliba + 19 = buttle
 tamper + 20 = jungly
 unison + 21 = pidjin
 vagile + 22 = chawer
 welwel + 23 = tibbit

Zaarah + 26 = Hazara

ziarat + 1 = jubbas
 yercum + 2 = towage
 xeroma + 3 = purdah
 wachna + 4 = regale
 vidduy + 5 = dizain
 Uchean + 6 = taking
 Tabeal + 7 = Shilha
 saddhu + 8 = capill
 recule + 9 = unland
 Quiche + 10 = somare
 packet + 11 = Plevna
 oafish + 12 = mature
 naftha + 13 = sugann

madefy + 14 = stroma
 lactyl + 15 = parian
 kobird + 16 = hearty
 Jaakan + 17 = barrer
 ilativ + 18 = sandal
 hafnyl + 19 = gyrate
 giggitt + 20 = Cacana
 fitful + 21 = pagoda
 effere + 22 = banaba
 deflux + 23 = brucia
 circot + 24 = grampa
 befist + 25 = dasher
 alerce + 26 = cereal

Curiously, a complete list of six-letter words was possible by reversing the alphabet with respect to step size.

If one insists on both words beginning with the same alphabetical letter, the following nearly-complete list of six-letter words results:

Abiner + 13 = avenor
baktun + 7 = Brahui
calden + 17 = curvet
Danize + 4 = dirhem
eggcup + 24 = encase
faured + 14 = fortis
Gabdes + 14 = groups
hagbut + 13 = hognut
Icerya + 10 = imbosk
jarfly + 9 = Joshua
kernos + 22 = kojang
lampit + 18 = lashed
mabuti + 18 = metals

nather + 13 = nauger
oarlop + 3 = ordurs
pacing + 2 = picker
quarte + 26 = quatre
rachet + 13 = repugn
sachem + 6 = skyng
tangib + 11 = tryml
ugsome + 6 = umyaks
vailier + 13 = vinery
wailer + 22 = washen

ycercum + 22 = Yanqui
Zareah + 8 = Ziphim

A curiosity noted in passing was TANGER + 13 = TANGER, an identity shiftgram, possible only for shiftgrams of step size 13. Note that Q employs a step size of 26, so that the two words are transpositions; it is desirable to avoid this special case if possible.

Suppose that one considers alphabetic letter shifts only. It is possible to find an alphabetical list of six-letter examples for all letters but Q and Y (and the inferred reformed spelling 'arizer' to match J):

aphtha + 19 = Tiamat
banian + 4 = fermer
caddaw + 8 = killie
dionym + 6 = joutes
elated + 15 = tapits
farrel + 13 = sneery
gedder + 22 = cazzan
Hadith + 11 = slotes
iddats + 11 = tooled
jarina + 17 = arizer
kernel + 23 = ganjah
ledder + 22 = hazzan
manful + 7 = thumbs

Napean + 4 = retier
orphan + 13 = becuna
pyrryl + 24 = rattan

reefer + 9 = annona
sappan + 4 = wetter
Tillim + 6 = zorros
Urijah + 17 = lizary
verver + 9 = enaena
wiggin + 6 = commot
xister + 22 = teopan

zanana + 4 = derere